Future Supportability of 1030/1090 MHz Systems & Operations in the NAS

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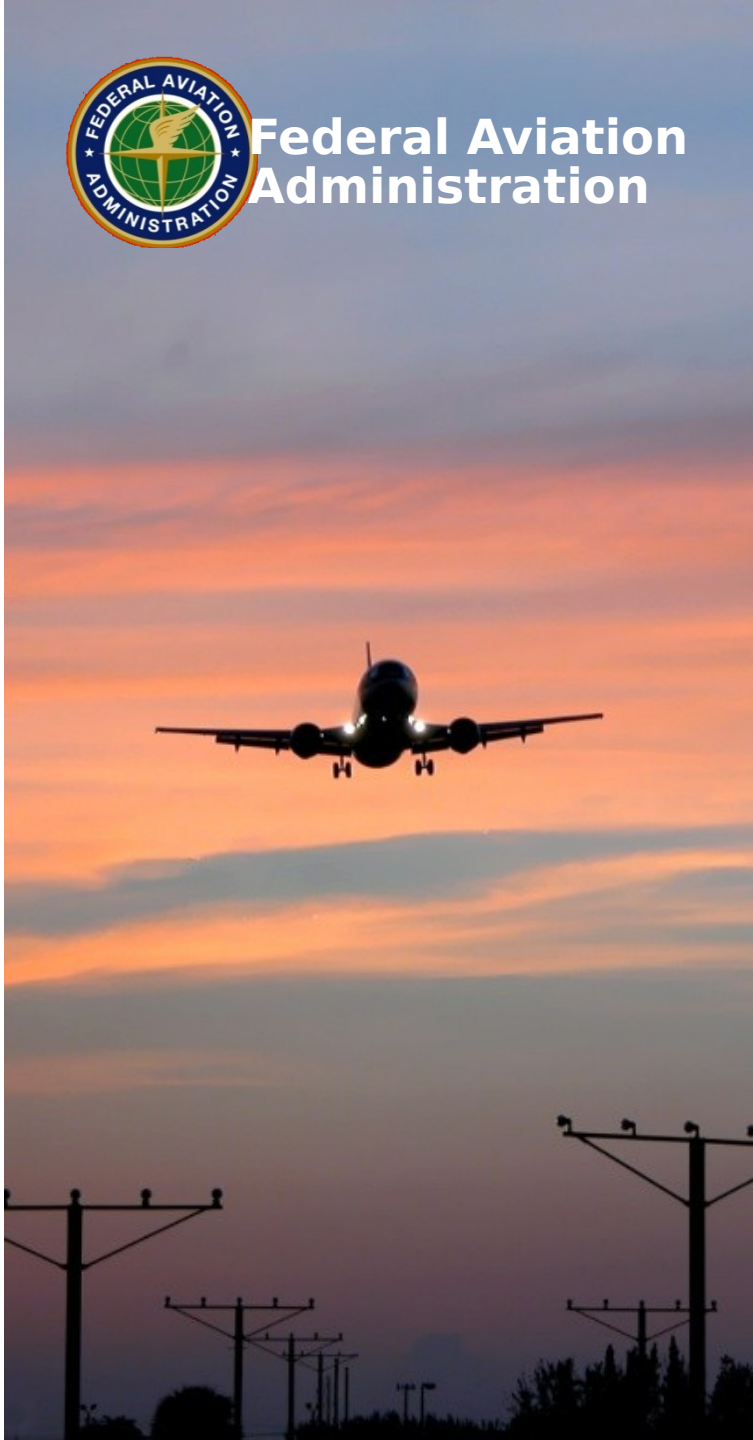

FAA Roles and Responsibilities

- As the national coordinator for the 1030/ 1090 MHz spectrum, the FAA is responsible for ensuring the efficient use and electromagnetic compatibility between ALL surveillance systems that utilize the frequency pair
- Protection of the channel bandwidth includes both co-channel surveillance systems and adjacent channel electronic systems
- FAA systems do not necessarily receive first priority, the order of priority is assigned to the service performed regardless of ownership

National Airspace System (NAS) Surveillance

- **1030/ 1090 MHz is used for safety and regularity of flight in the NAS**
- **Traditionally, 1030 MHz has been used to request for information (the interrogation) & 1090 MHz has been used for the response to the request (reply) in order to determine the position of aircraft**
  - Request (interrogation) may come from the ground, air, or sea
  - Position is determined by interrogation/reply time delay and bearing from calculating position in the antenna beam
- **Order of system priority:**
  - Highest Priority: Air Traffic Control (ATC) and Traffic Collision and Avoidance Systems (TCAS), Multilateration services (ASDE-X, WAM), Automatic Dependant Surveillance-Broadcast (ADS-B)/ Traffic Information Service-Broadcast (TIS-B) systems, and 1090 MHz Vehicle Transmitters
  - Lowest Priority: All other systems that are not responding to the highest priority systems, i.e. test/ R&D, training, non-ATC systems like situational awareness Mode 3/A,C,4,5, regardless of agency ownership

How does the FAA Manage the 1030/1090 MHz Frequency Pair?

- **Separate surveillance systems in space and time using engineering criteria established in FAA Orders or developed through research studies along with interference models**
- **Critical to preserve the surveillance performance of the link**
  - Minimize the False Replies Unsynchronized In Time (FRUIT)
  - Minimize aircraft transponder unavailability (effects due to suppression, reply, delay times)
  - Prevent false targets from being displayed to Air Traffic Control
- **Methodologies**
  - Assign the lowest possible average interrogation rate
  - Require Side Lobe Suppression, also required by ICAO, DoD, NATO, NTIA
  - Require the power be set commensurate with the surveillance range
  - Require the use of monopulse technology
  - Blanking transmission in certain azimuths, as with Mode-4
  - Separate adjacent systems average PRF
  - Manage Mode S Interrogator Identifier (II) codes
  - Require significant stagger or jittered operation

Why Does the FAA Care About IFF?

- The FAA is responsible for managing the NAS and each of its components
- IFF uses frequencies that have shared civil/military usage
- Military IFF systems interact with the ATC equipment
- ATC equipment is used to ensure the safety within NAS
- Improper IFF use and overuse disrupts the ATC equipment's ability to function properly

Organizations with IFF Policy, and Requirements that Regulate Usage

- ICAO: State Letter
- AIMS: 03-1000A
- NTIA: NTIA Manual (47CFR, Part 300)
- FCC: 47CFR, Part 87
- FAA: Based on ICAO and RTCA Docs
- NATO STANAGs

NextGen Surveillance

- **Automatic Dependant Surveillance – Broadcast will be the primary surveillance link in the future**
  - Automatic because the aircraft doesn't need to be interrogated to provide information
  - Dependant because the ADS-B aircraft transmitter must be active (cooperative) unlike primary "skin paint" radar
  - Aircraft position information can be received by other systems passively or information can be solicited
  - Broadcast messages periodically emitted by aircraft reduce the need to uplink requests for information
- **The U.S. has adopted a dual link strategy for ADS-B**
  - Multi-agency U.S. decision to use 978 and 1090 MHz, see www.jpdo.gov
  - Universal Access Transceiver (UAT) on 978 MHz will primarily be used by general aviation users
  - 1090ES (1090 MHz Extended Squitter) will primarily be used by commercial and business aircraft – the Extended Squitter is an existing Mode S downlink format message
  - 1090ES is the international ADS-B link
- **ADS-B has the potential to greatly reduce 1090 MHz activity**
  - The transition from legacy cooperative radars to ADS-B will increase channel utilization during the transition period

Overview of FAA Concerns for the Future of 1030/1090 MHz

- **The FAA must ensure the performance of NextGen systems, to include ADS-B, TCAS, SSR (ATCRBS and Mode S), and MLAT (1030/1090 MHz dependent systems)**
  - Collectively, these are referred to as aeronautical surveillance and collision avoidance systems, which are the primary functions allocated to use 1030/1090 MHz
  - NextGen was developed by the JPDO with active DoD and DHS participation
  - The FAA is responsible for ensuring adequate performance of each of these systems
- **Interference generated by surveillance and collision avoidance systems, to include military interrogators, affect the performance of each system differently**
  - Many changes, which are increasing the use of 1030/1090 MHz, are simultaneously occurring in the NAS and certain areas are already at the interference limit
  - The changes are being led by the FAA, DoD, and DHS and each must demonstrate that the critical NextGen safety services will remain available during and after the changes are implemented
- **NextGen system performance requires adequate transponder availability and controlling the # of replies in the environment**
  - All systems must use the minimum resources necessary to perform their intended functions
  - The impact on NAS safety must be evaluated prior to development and implementation
  - The impact must only occur where absolutely necessary (equipment & location limitations)

Overview of FAA Concerns for the Future of 1030/1090 M

- **FAA, DoD, and DHS must share an understa of current and future usage of 1030/1090 M**
  - Locations of IFF systems
  - Time of Day
  - Impact on environment
- **FAA is currently supports over twenty unique IFF systems on hundreds of DoD and DHS platforms**
  - The acquisition community allows IFF systems to be procured based on design requirements that do not take into account the aggregate impacts of all of these platforms in the NAS
  - Each system has a different impact
- **FAA agency risk identified**
  - 1090 MHz Spectrum Congestion Reports for 2020 and 2035 conclude that without the proper control of the spectrum, the air traffic growth and additional use of the 1090 MHz frequency will limit the performance of NextGen systems
  - Possible Impacts include safety of flight and a reduction in capacity of operations and range
  - To properly control the spectrum, the FAA needs DoD and DHS input on IFF systems or anything that causes transponder activities and in high, medium, and low density

FAA Strategy for NextGen 1030/1090 MHz-Dependent Safety Systems

- **<u>Current Situation</u>: Since there is currently no way to control the aggregate IFF activity in a geographic area, the FAA will use technical and operational restrictions on each interrogator platform to limit its specific contribution to the 1030/1090 signal environment**
  - FAA has to make assumptions on the locations and usage of DoD and DHS interrogators in the NAS
  - Limits on interrogator operations, to include the max # of interrogators, # of interrogations, modes of interrogation, or location/azimuths
  - FAA is also working to better define the boundaries of the High, Medium, and Low Aircraft Density Areas and what the threshold should be for the operation of interrogators in each of those

FAA Strategy for NextGen 1030/1090 MHz-Dependent Safety Systems (cont.)

- **<u>Desired Solution</u>: DOD and DHS manage a budget of some 1030/1090 MHz activity**
  - Thresholds derived after modeling current and future operations and through FAA/DOD/DHS joint analysis
  - DOD (possibly OSD) and DHS would need to ensure the budget limits are not exceeded in a geospatial/temporal area
  - DOD, DHS, and FAA will monitor the 1030/1090 MHz activity through the frequency assignment process

More Detailed Strategy

- **FAA is developing geographical areas of High, Medium, and Low potential of interference**
  - Geospatial and temporal
  - Using a density of interrogations/ density of aircraft approach
- **DoD identify platforms allowed to interact with each NAS environment**
  - Organize platforms based on local interference environment (H/M/L)
  - DoD manage platform access up to the limit, FAA will coordinate assignments up to the limit (JTIDS de-confliction server model)
- **DoD to define a strategy for mobile systems that minimizes active interrogations and maximizes the use of passive acquisition**
  - Active interrogation limits based on 1090 MHz Congestion Alternatives Analysis
  - Utilize ADS-B for ID and tracking (surveillance)
  - Investigate use of techniques that expands receiver listening area and minimizes area of interrogation
- **Create a permanent 1030/1090 MHz Spectrum Monitoring Program**
  - Monitor management of the transponder occupancy/reply budget
  - Measure and assess current system health
  - Use data to predict future compatibility and capacity (Joint-agency

How will the aviation community use ADS-B?

- **Aircraft will be able to communicate their position, ID, and other safety information to each other allowing self-separation using ADS-B**
- **The FAA Surveillance and Broadcast Services radio stations will broadcast Traffic Information Service – Broadcast (TIS-B) data and translate the data between the two links**
  - TIS-B provides ADS-B equipped aircraft with position reports from legacy ground based radar systems
  - Since there are two links, the ground based radio station will relay the UAT data on 1090ES and vice versa
- **Under ideal weather conditions, ATC will take on more of an Air Traffic Management/ Planning role**
- **Many commercial aircraft are transmitting 1090ES ADS-B messages today and the DoD has incorporated ADS-B in the MILACAS-FR (DF=19 messages)**

How does the FAA protect legacy systems from ADS-B interference?

- **Aircraft that have TSO-certified ADS-B equipment must meet the ICAO SARPs and RTCA MOPS which were developed to protect the legacy systems**
  - The 1090ES message rate is currently limited to 6.2 messages/sec
- **The ADS-B radio station design specification was based on the results of studies that led to a criteria that limits the power and message rate when in proximity to a legacy radar system**
  - When new radio stations are requested, the FAA uses the protection criteria to protect area systems according to the spectrum access priority identified earlier
  - If the service requirement cannot be met with a reduction in power and message rate, the radio station blanks transmissions when it senses the legacy radar beam incident on its antenna

FAA Use of Wide Area Multilateration (WAM)

- **The FAA is implementing WAM systems in Colorado and Alaska where terrain shielding prohibits radar coverage using legacy rotating systems**
- **Benefits include:**
  - Enhanced Safety – being able to “see” aircraft that are currently outside of radar coverage
  - Improved Overall Flow Efficiency – arrival and departure efficiency is improved since “one-in-one-out” procedure required for areas outside of legacy radar coverage would be unnecessary
  - ADS-B Benefits:
    - WAM can be an ARNS backup for ATC separation when AM(R)S ADS-B services are unavailable, i.e. GPS outage
    - Acts as a surveillance source for ADS-B providing validation of GPS-derived position through ARNS triangulation
  - Economic Benefits:
    - Improved surveillance translates into more efficient flight tracks that reduce fuel consumption, lost revenue due to diverted flights and increase operational capacity

Trends in IFF and Future Use

Current IFF Challenges

- DoD is upgrading interrogators and transponders across the entire department, workload is immense
- Each platform (ship/aircraft/ground system) has different issues, many are very complex
- There are so many systems in the pipeline, even simple tracking of all the systems' hardware, software versions, and AIMS certification status has become challenging
- Use of ground test equipment for transponders and interrogato is carefully evaluated and coordinated

Current IFF Challenges

- **Some POs are not following the certification process and delivering platforms without proper platform certification**
  - Risks possible grounding, FAA restrictions
- **Problems over the last couple years with military IFF systems also has ICAO attention**
- **ICAO State Letter recently released**
  - Highlights incorrect military testing practices and impacts, provides guidance
  - Established requirement for monopulse antenna and processing if using Mode S

IFF: Expanding Airborne Use

- **Historical Implementation**
  - Small number of fighter aircraft
  - Combat ID function only
- **NTIA Regulation: Prior national-level coordination is required and operational capabilities and parameters must be established when an interrogator is operated airborne**
- **Current Trends**
  - All fighters
  - Used for situational awareness
  - Airborne use expands the potential impact to systems as far away as 600 NM

IFF: Ship Installations

- **The NTIA Manual (47CFR, Part 300) states that "operational agreements with the applicable FAA Regional Coordinator are required when operations are within 185 kilometers of the U.S. Coast or its possessions"**
- **Ships are inherently mobile platforms**
- **The interrogator PRR must be compatible with the local shore based interrogators**
  - It is very difficult to coordinate universal PRR's
- **Pier-side testing is a problem**
  - The transponder altitude (Mode C) reply needs to be set to -1000 ft AMSL

ATCRBS Reduction

- ATCRBS is 40-yr old technology
- The FAA is currently using Monopulse and Mode S technologies
- The FAA is moving towards passive technologies for the 2020 timeframe, based on anticipated congestion of this band
- ICAO issued a State Letter and is recommending that no new ATCRBS systems be deployed
- Future ATCRBS systems will be harder to support

IFF: Test Sets

- First, all test sets need to be certified by the AIMS PO before they are deployed
- Second, all test sets need to have a frequency assignment
- While test sets are usually not a concern for interference, the units being tested can cause interference
- Test procedures need to be coordinated with the FAA
- Review ICAO State Letter for guidance on requirement for RF cover needed when testing outdoors and inside

IFF: Mode S

- **Mode S is a Civil Mode**
- **Mode S is a package**
- **Mode S requires:**
  - A major change to the interrogator design
  - A monopulse antenna and processor
- **If implemented improperly, Mode S can actually cause a total loss of surveillance**
- **FAA has been approached by the US and Canadian Defense/Security services to allow Mode S interrogation from mobile non-NAS platforms**
  - A non-ATC mobile Mode S implementation strategy does not exist, FAA, DoD, and DHS will need to develop jointly The FAA would like to see new Mode S interrogators use passive acquisition & tracking

IFF: Mode S Implementation Strategy Recommendations

(If FAA leadership decides to support this DoD request)

- FAA Support a very limited introduction of non-NAS mobile Mode S interrogators
  - DoD work to integrate other non-NAS users (DHS, CAN DND) in strategy
  - DoD ensure systems compatible with the NAS and compliant with ICAO
  - DoD work towards defining a limit and then a ratio between different platform types that would be allowed to utilize the limit of active interrogations
  - DoD define mission profiles covered by strategy (humanitarian, homeland defense/security, training) with platform class requirements
  - DoD/FAA develop a Mode S ID and Tracking strategy using ADS-B with active Mode S interrogation restricted for target validation purposes
  - DoD/OSD manage and limit number of platforms geospatially and temporally
- Develop overall spectrum monitoring capability
  - Ensure long-term surveillance system compatibility
  - Ensure capacity available for NextGen and other future requirements
  - Identify unintended interference impacts to the safety of the NAS

Overall IFF Issues

- **There continues to be a need for close and early coordination between the DoD and FAA prior to closing the box or completing the platform integration**
- **There are several IFF programs that are currently struggling with issues due to lack of timely coordination with the FAA**
  - These problems are affecting the DoD's ability to test and operate its IFF systems
- **The FAA has expanded its IFF Team to support the DoD's increase in requirements and requests for certification and assignments**